

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Mr. Larry Lawson, Director
Division of Water Program Coordination
Virginia Department of Environmental Quality
629 Main Street
Richmond, VA 23219

Dear Mr. Lawson:

The Environmental Protection Agency (EPA) Region III is pleased to approve the Total Maximum Daily Load (TMDL) report for the primary contact use (bacteria) impairment on Cub Run. The TMDL report was submitted to EPA for review in March 2004. The TMDL was established and submitted in accordance with Section 303(d)(1)(c) and (2) of the Clean Water Act to address an impairment of water quality as identified in Virginia's 1998, Section 303(d) list.

In accordance with Federal regulations at 40 CFR §130.7, a TMDL must comply with the following requirements: (1) designed to attain and maintain the applicable water quality standards, (2) include a total allowable loading and as appropriate, wasteload allocations (WLAs) for point sources and load allocations for nonpoint sources, (3) consider the impacts of background pollutant contributions, (4) take critical stream conditions into account (the conditions when water quality is most likely to be violated), (5) consider seasonal variations, (6) include a margin of safety (which accounts for uncertainties in the relationship between pollutant loads and instream water quality), (7) consider reasonable assurance that the TMDL can be met, and (8) be subject to public participation. The enclosure to this letter describes how the TMDL for the primary contact use impairment satisfies each of these requirements.

Following the approval of the TMDL, Virginia shall incorporate the TMDL into the Water Quality Management Plan pursuant to 40 CFR § 130.7(d)(2). As you know, all new or revised National Pollutant Discharge Elimination System permits must be consistent with the TMDL WLA pursuant to 40 CFR §122.44 (d)(1)(vii)(B). Please submit all such permits to EPA for review as per EPA's letter dated October 1, 1998.



If you have any questions or comments concerning this letter, please don't hesitate to contact Mr. Thomas Henry at (215) 814-5752.

Sincerely,

Jon M. Capacasa, Director
Water Protection Division

Enclosure



Decision Rationale

Total Maximum Daily Load for the Primary Contact Use (Bacteriological) Impairment on Cub Run

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDL for the primary contact use (bacteriological) impairment on the Cub Run. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

- 1) The TMDL is designed to implement applicable water quality standards.
- 2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
- 3) The TMDL considers the impacts of background pollutant contributions.
- 4) The TMDL considers critical environmental conditions.
- 5) The TMDL considers seasonal environmental variations.
- 6) The TMDL includes a margin of safety.
- 7) There is reasonable assurance that the TMDL can be met.
- 8) The TMDL has been subject to public participation.

II. Background

The Cub Run Watershed is located in Rockingham County, Virginia. The watershed is 17,126-acres in size. The 13.94 mile impaired segment of Cub Run begins at its headwaters and terminates at its confluence with the Shenandoah River. Cub Run is a rural watershed with approximately 51% of the land committed to agricultural activities and 45% of the land being forested. The remaining lands in the watershed are composed of residential developments, transitional lands, grass lands, and wetlands.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 13.94 miles of Cub Run (VAV-B34R) on Virginia's 1998 Section 303(d) list as being unable to attain its primary contact use due to violations of the bacteriological criteria. This decision rationale will address the TMDL for the primary contact use impairment on Cub Run.

Cub Run was listed for violations of Virginia's fecal coliform water quality criteria. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA has been encouraging the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth adopted e-coli and enterococci criteria in 2002. Streams are evaluated via the e-coli and enterococci criteria after 12 samples have been collected using these indicator species. Twelve e-coli samples have been collected from Cub Run. Therefore, compliance with the primary contact use is now based upon the e-coli criteria.

As Virginia designates all of its waters for primary contact, all waters must meet the current bacteriological criteria to support this use. Virginia's standard applies to all streams designated for primary contact for all flows. The new e-coli criteria requires a geometric mean concentration of 126 colony forming units (cfu)/100mL of water with no sample exceeding 235 cfu/100mL of water. Unlike the fecal coliform criteria which now allows for a 10% violation rate the new e-coli criteria requires the concentration of e-coli not exceed 235 cfu/ 100mL of water. Although, the TMDL and criteria require that the standard not be exceeded waters are not placed on the Section 303(d) list if their violation rate does not exceed 10%.

The TMDL submitted by Virginia is designed to determine the acceptable load of e-coli which can be delivered to the impaired water, as demonstrated by the load-duration approach. The load-duration approach is considered an appropriate method to analyze the impaired water through its analysis and comparison of observed flows, in-stream bacteria concentrations, and the numeric water quality criteria.

The load-duration approach analyzes the stream's entire flow record to find a correlation between flow regimes and bacteriological concentrations. The load-duration approach uses flow data collected by a local gaging station, in this instance the United States Geological Survey (USGS) gage 01622000 was used for the TMDL development process. This gage is located on the North River, which like Cub Run is a tributary to the Shenandoah River. The North River is a much larger water than Cub Run, its watershed is 14 times larger than that of Cub Run. A regression analysis was drawn between the observed flow data at the USGS gage and grab flow samples taken from the impaired waters. Flow measurements were taken at the mouth of Cub Run from 2002 through 2003. USGS gage 01621050 on Muddy Creek was analyzed as a potential reference gage as well. Although, the watershed and the flows observed on Muddy Creek were more similar to those observed on Cub Run the regression between these two waters was not as strong as it was between Cub Run and North River. The Commonwealth determined that the regression was more critical than watershed or flow size when choosing a reference water. The Commonwealth will analyze this assumption for TMDL development in the 2006

cycle.

The measurement data from Cub Run was entered into Excel spreadsheets along with daily mean flow data from the nearby, long term, continuous record gaging stations.¹ Using Excel data analysis tools the impaired watershed's flow was correlated to the observed data from the USGS gage. The flow data from the impaired water was plotted against the daily mean flow data from USGS gage 01622000. Excel plotted a best fit line through the data and developed a regression equation for the relationship. Once the regression equation was developed, a flow for the impaired watershed could be ascertained for any flow observed at gage 01622000.

The next step of the TMDL was to determine what organisms or sources are responsible for the pollutant loading to the stream. Since fecal coliform is associated with warm blooded animals as mentioned above, it was necessary to determine which animals were providing the bacteria loadings to Cub Run. Through a process known as bacterial source tracking (BST), VADEQ was able to breakdown the sources of bacteria into four categories. The four categories were human, pets, livestock, and wildlife. Three of these four sources are anthropogenic in origin and can be controlled through a variety of management techniques. Wildlife, which may be attracted to certain areas due to anthropogenic reasons is considered a natural source of bacteria.

The BST approach used by VADEQ is known as the Antibiotic Resistance Approach (ARA) it measures the bacteria's resistance to a suite of antibiotics. The assumption is that bacteria associated with humans will have the highest resistance to antibiotics due to previous exposures to antibiotics. Livestock and pets would have the next highest resistance, while wildlife would exhibit the least resistance. In order to conduct this work waste samples from known sources had to have their resistance measured, this information was placed into a library. The resistance of the bacteria collected in water samples was compared to the data in the library to determine its source. For additional information of the ARA please refer to Appendix B of the TMDL.

The data collected in steps one and two were then combined to determine the impact of the bacterial sources to water quality in Cub Run. VADEQ collected one year of BST samples from the water, for each sample VADEQ determined the bacterial concentration and the percent loading derived from each source. This percent loading for each source category was averaged over the annual period and this average percent loading was used to determine the loading for each source. In the Cub Run TMDL, the highest bacteria violation occurred during a flow of 43 cubic feet per second, only 10% of the flows at Cub Run are expected to exceed this flow. The e-coli load for this flow event was 7.61E+15 cfu/ year. The allowable load at this same flow was 8.94E+13 cfu/year. This represents a 99% reduction in loadings. The reductions in loadings were then applied to average annual e-coli load. The BST data demonstrated that livestock, pets, humans, and wildlife represented 38, 21, 10, and 32 percent of the load respectively. Therefore,

¹VADEQ, March 2004, "Bacteria TMDLs for Sepulcher Creek, Toms Creek, Little Toms Creek and Crab Orchard Branch

it was determined that all sources must be reduced.

Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the bacteria criteria. BST sampling data collected on Cub Run indicated that bacteria from wildlife represents 32 percent of the load. Many of Virginia's TMDLs, including the TMDL for Cub Run, have called for some reduction in the amount of wildlife contributions to the impacted streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In Phase 1 of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted. It should be noted that VADEQ averaged the percent loads associated with each BST sample, which removed the magnitude of loading from the source analysis. The average annual loading for each source can be determined by dividing the average concentrations from each source over the sampling period by the average total concentration. VADEQ will evaluate the differences between the two source assessment methods during the next TMDL cycle.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL (cfu/yr)	WLA (cfu/yr)	LA (cfu/yr)	MOS
Cub Run	E-Coli	6.53E+13	1.74E+10	6.53E+13	Implicit

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a primary contact (bacteriological) impairment TMDL for Cub

Run. EPA is therefore approving this TMDL. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of bacteria from both anthropogenic and natural sources have caused violations of the water quality criteria and designated uses in the Cub Run Watershed. The water quality criterion for fecal coliform was a geometric mean 200 cfu/100mL or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a 30 day period are required for the geometric mean standard. The Commonwealth has changed its bacteriological criteria as indicated above. The new e-coli criteria require a geometric mean of 126 cfu/100mL of water with no sample exceeding 235 cfu/100 ml.

The load-duration approach, described above was used by the Commonwealth for the development of the Cub Run TMDL. This approach uses the flow data from a USGS gage, in-stream water quality data, a regression equation, and BST data to quantify the bacteria loading and the sources responsible for that loading. The load-duration approach in this instance developed a flow record for the impaired reach based on observed flow data on the North River. For each flow along the load-duration curve the allowable load can be determined by multiplying the numeric criteria by the flow. The observed loads were determined by multiplying the observed concentrations by the flow that was observed at that time. In order to insure that the TMDL was protective of all flow conditions, it was developed for the flow that exhibited the greatest difference between the observed and allowable loadings. This reduction was then applied to the average annual load which was determined by multiplying the average annual flow by the bacterial concentration observed at the largest violation.

Through the use of BST, VADEQ was able to breakdown the sources of bacteria into four categories. The four categories of bacteria sources were human, pets, livestock, and wildlife. Three of these four sources are anthropogenic in origin and can be controlled through a variety of techniques. Wildlife, which may be attracted to certain areas due to anthropogenic reasons is considered a natural source of bacteria.

VADEQ collected one year of BST samples from the water. VADEQ determined the bacterial concentration and the percent loading derived from each source for each sample. The percent loading for each source category was averaged over the annual period. This average percent loading was used to determine the loading for each source.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of bacteria to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found

in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

There are 10 point sources of bacteria in the Cub Run Watershed. All of these facilities are regulated under a general permit that allows them to discharge a maximum of 1,000 gallons per day with an e-coli concentration of 126 cfu/100ml. The WLA for these facilities is provided in Table 2 and can be determined by multiplying the flow by the concentration by 365 after converting the units.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), “Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7.” Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2 - Bacteriological (E-Coli) WLAs for the Cub Run

Facility Name	Permit Number	Flow (gpd)	Concentration (cfu/100ml)	Allocated Load (cfu/yr)
Residence	VAG401012	1,000	126	1.74E+9
Residence	VAG408050	1,000	126	1.74E+9
C&D Pools and Spas	VAG401611	1,000	126	1.74E+9
Massanutten Exxon	VAG401528	1,000	126	1.74E+9

Truth Light & Life Mission	VAG401800	1,000	126	1.74E+9
Loker Auto Sales	VAG401835	1,000	126	1.74E+9
Residence	VAG401471	1,000	126	1.74E+9
Residence	VAG401493	1,000	126	1.74E+9
Residence	VAG401439	1,000	126	1.74E+9
Residence	VAG401914	1,000	126	1.74E+9

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), load allocations (LAs) are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

The load-duration approach used BST data to determine the bacteria load from each source. According to the BST data livestock, pets, humans, and wildlife were responsible for 38, 21, 10 and 32 percent of the load respectively. Table 3 documents the bacteria loading by source category.

Table 3 - LA for Bacteria (fecal coliform) for Cub Run

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
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Livestock	2.11E+15	2.47E+13	99
Pets	1.14E+15	1.34E+13	99
Human	5.37E+14	6.31E+12	99
Wildlife	1.77E+15	2.08E+13	99

3) The TMDL considers the impacts of background pollution.

The TMDL considers the impact of background pollutants by considering the bacterial load from natural sources such as wildlife.

4) The TMDL considers critical environmental conditions.

According to EPA's regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the impaired creeks is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards². Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. This was addressed in the Cub Run TMDL by modeling the reductions to the flow that exhibited the greatest disparity between observed and allowable concentrations and requiring the reductions needed to attain the criteria under these conditions to average annual conditions.

5) The TMDL considers seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. The loadings to Cub Run were investigated on a monthly basis to determine if seasonality existed between the sources. Based on the BST, results it was determined that there was minimal seasonal impacts to loading and the source loads were averaged on an annual basis. The TMDL also developed a 78 year flow record for Cub Run.

6) The TMDL includes a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account

²EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia included an implicit MOS in the TMDL through the use of conservative modeling assumptions. The Cub Run TMDL was modeled to the single-most extreme water quality violation event and applied the reductions necessary during that event to all conditions.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

8) The TMDL has been subject to public participation.

The TMDL was subject to the Commonwealth's public participation process. The meeting and comment period for this TMDL was public noticed in the Virginia Register. There was a public meeting held on February 12, 2003 in McGaheysville, VA. Thirty-four people attended the public meeting. One set of comments was received by VADEQ during the thirty-day comment period.